REMARKS

This application has been amended. Support for these amendments can be found, for example, between line 25 of page 3 and line 10 of page 4, between lines 5 and 10 of page 6, and between line 24 of page 9 and line 8 of page 10 of the application as filed as well as in the previous version of the claims. Thus, no new matter has been added. Claims 1-4 remain pending, of which claims 1 and 4 are in independent form.

Claims 1-4 stand rejected under 35 U.S.C. 103(a) for obviousness over each of U.S. Patent Nos. 4,509,889 to Skogberg et al., 4,511,289 to Herron, and 4,636,115 to Davis et al. This rejection is respectfully traversed.

Claim 1 is directed to a high-strength steel pipe rockbolt that has an expansive rockbolt main body made from a shaped pipe having one or more concavities extending in an axial direction. The shaped pipe is made by forming a high-strength steel sheet having a thickness of 1.8–2.3 mm, a tensile strength of 490–640 N/mm^2, and an elongation of at least 20%. Claim 4 is directed to a method of manufacturing a steel pipe rockbolt including steps of processing a steel sheet of 1.8–2.3 mm in thickness with a tensile strength of 490–640 N/mm^2 and an elongation of at least 20% into a welded pipe of 50–55 mm in outer diameter, roll-forming the welded pipe to a shaped pipe having an outer diameter of 34.0–38.0 mm and one or more concavities extending in an axial direction, sizing the shaped pipe to a predetermined length, swaging the ends, hermetically fixing sleeves to the ends, and drilling the sleeve at the second end for formation of a pressure fluid inlet leading to an interior of the shaped pipe. As explained in the application, the selection of high-strength steel allows for the use of a thinner steel sheet, and particularly a steel sheet having a thickness of between 1.8 and 2.3 mm. A thinner steel sheet allows for a larger bending radius in a pipe-shaping process, causing a corresponding decrease in the cumulative stress induced during pipe-shaping. Reducing the cumulative stress is effective in inhibiting cracks in the pipe which can be induced by strains in the pipe-shaping, swaging, and pressure-expanding processes.

In addition to the above advantages, the rockbolt of the present application undergoes expansive deformation (i.e. bulging of the cavity; see Fig. 2 and page 1) in considerably less time and under a considerably reduced pressure than conventional rockbolts. For instance, in the Examples section, a rockbolt manufactured from a 2.1 mm thick high-strength steel sheet was compared with a conventional rockbolt manufactured from a 3.0 mm thick steel sheet having a tensile strength of 300 N/mm^2 and an elongation of

35%. The inventive rockbolt began expansive deformation when a hydraulic pressure in the pipe reached 7 MPa, and hydraulic expansion continued at a pressure of 5 MPa. The time required for expansion was 31 seconds. On the other hand, expansive deformation of the conventional rockbolt occurred at 17 MPa, and continued at a pressure of 10MPa. The time required for expansion was 41 seconds. The nearly 25% reduction in expansion time significantly reduces the time required to fix each bolt and the approximately two-fold reduction in pressure greatly reduces the load applied to the hydraulic pump used in the bolt-fixing operation. Furthermore, the inventive rockbolt also had a strength of 170 kN when subjected to a pullout test. (Specification as filed, page 18)

Skogberg is directed to a tube-formed expansion rockbolt. Skogberg fails to disclose a rockbolt manufactured from a high-strength steel sheet, much less a high-strength steel sheet falling within the particular parameter ranges recited in the claims. Skogberg mentions a tube that can be expanded by subjecting it to a pressure ranging from 10-50 MPa (100-500 bar) (Col. 2, lines 15-17) Skogberg mentions that a thin-walled tube made of mild steel could be expanded by pressures below 10 MPa (100 bar) and thick-walled, hard steel tube could require pressures greater than 50 MPa (500 bar) for expansion. (Col. 2, lines 20-24)

Herron discloses a rockbolt having an expandable tube and a depression formed therein. The tube is prepared from mild steel. (Col. 1, lines 52-53) Other than the indication that the tube is prepared from mild steel, Herron provides no further discussion or suggestion as to the appropriate geometries or properties of the steel tube.

Davis is also directed to a rockbolt having a depression formed therein. The rockbolt has a hollow shank portion which comprises a "relatively thin-walled" tubular metal member of a suitable deformable material, such as low-carbon steel (e.g., 1016 carbon steel) of a "suitable thickness (e.g., one-eighth inch)." (Col. 3, lines 25-30) Of the three patents relied on in the Office Action, only Davis provides any mention of the thickness of the steel sheet. However, the suitable thickness example disclosed in Davis is 3.175 mm (1/8") which is not only clearly outside the scope of the claims, but is more akin to the conventional (comparative) rockbolt described in the Examples section of the subject application. As shown therein, such a rockbolt requires a significantly longer expansion time and expansion pressure than the inventive rockbolt. There is nothing in Davis that would suggest a thickness falling within Applicants' claimed range.

As described above, none of the patents relied on in the Office Action teach, disclose, or suggest a rockbolt formed from a high-strength steel sheet having the properties and geometries recited in the claims. Moreover, Applicants have shown by way of comparative data that the claimed rockbolt provides significant benefits over more conventional rockbolts, including rockbolts similar to those in the cited art. Despite these clear deficiencies in the prior art, the Office Action asserts that the features of the claimed invention would be obvious to one skilled in the art and amount to nothing more than a design choice that would a yield predictable solution with a reasonable expectation of success. (Office Action, page 2) However, Applicants respectfully submit that this reasoning falls considerably short of establishing a *prima facie* case of obviousness. The conclusions drawn in the Office Action are not culled from the teachings in the prior art, and appear to be at least partially based on the teachings in the present application. For instance, the Office Action has provided three patents in the field of rockbolting, yet none of these patents suggest or even mention the use of a steel sheet like that recited in the claims. Absent some rationale or other teaching establishing that, at the time of Applicants' invention, one skilled in the art would find it obvious to modify the prior art rockbolts to arrive at the claimed rockbolt and method of manufacture, the rejection under 35 U.S.C. 103(a) is improper.

For all the foregoing reasons, Applicants submit that the pending claims are patentable over the prior art of record and are in condition for allowance. Accordingly, Applicants respectfully request reconsideration of the outstanding rejection and allowance of pending claims 1-4.

Respectfully submitted,

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